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The following statements are taken from documents submitted by the applicant.

A request for examination in accordance with [] 44 PatG [/= Patent Law/] has been filed.

(54) Movable, combustion-operated operating tool with a changeable primary chamber.

(57) The invention relates to a movable, combustion-operated operating tool, particularly a placing device for attachment elements, which has a combustion chamber (1) for the ignition of a combustible gas mixture. The size of a combustion space volume of the combustion chamber can be adjusted in order, in this manner, to be able to change the combustible gas mixture in the direction of rich or lean.

Description

The invention relates to a movable, combustion-operated operating tool, particularly a placing device for attachment elements.

The driving energy in operating tools of the stated type is provided through the internal combustion of a combustible gas mixture, such as of a mixture of air / combustible gas, for example, and is conveyed, by way of a piston, to an attachment element which is to be driven into an object. The combustible gas mixture can thereby be located in a single combustion chamber or, possibly, in different mixture ratios, in several partial combustion chambers of a combustion chamber subdivided by separating walls.

In the event that the combustion chamber is only divided into a precombustion chamber and a primary chamber, for example, the combustion is started in the precombustion chamber by means of an electrical spark produced by an ignition device, and a flame front begins to diffuse radially at a relatively slow speed. It thereby pushes uncombusted gas forward in front of it, which flows through the penetrating apertures present in the separating plate and enters into the primary chamber, in order to produce turbulence as well as precompression. If the flame front reaches the penetrating apertures to the primary chamber, then the flames, because of the constriction of the cross-section, cross over into the primary chamber as jets of flame and produce turbulence here. The thoroughly-mixed turbulent combustible gas mixture in the primary chamber is then ignited over the entire surface of the jets of flame. It burns at a high speed, which leads to a strong increase in the level of efficiency of the combustion, since the losses from cooling remain small.

The task which forms the basis of the invention is that of being able to better adjust the release of energy to the requirements or conditions set.

The solution of the task set is stated in the introductory portion of patent claim 1. Advantageous configuration of the invention are to be derived from the sub-claims.

The operating tool in accordance with the invention is characterized in that, the size of the combustion chamber is adjustable.

The size of the combustion chamber can, preferably, be adjustable through displacement of a combustion chamber wall, whereby the displaceable combustion chamber wall can also be such as is formed as combustion chamber frontal wall in a cylindrically-formed combustion chamber, and can be moved into the axial direction or longitudinal direction of the combustion chamber.

By that means it is possible, in devices with only a single combustion chamber which is not divided into partial combustion chambers, to change the volume of the combustion chamber so that, with conditions otherwise being the same, the combustible gas mixture present in the combustion chamber can be adjusted in the direction of lean or rich, in order in this manner to adjust the energy used by the operating tool.

A catch unit adjustable in the axial direction of the combustion chamber can thereby be provided for the displaceable combustion chamber wall in order to be able to provide a defined displacement of the combustion chamber wall and thereby a defined adjustment of the energy to be used. The catch unit can be formed, for example, as a support element traversing the displaceable combustion chamber wall, which [support element] is held on the internal wall of the combustion chamber. The support element can be screwed, by means of an external threading, for example, into a frontal-side internal threading of the combustion chamber so that, through the rotation of the support element, a simple possibility of adjustment of the size of the entire combustion chamber results. The support element can thereby be formed in the form of a circular plate and support an activating extension pointing outwardly and centrally, for example, by means of which it can be rotated.

If, in order to be able to divide the combustion chamber into a precombustion chamber and into a primary chamber, for example, a separating plate is located in the combustion chamber on the side of the displaceable combustion chamber wall oriented away to the support element, then the separating plate can be connected with an extension which projects through the combustion chamber wall and can be acted on by the support element. A pressure spring can thereby be positioned between the free end of the extension and the displaceable combustion chamber wall, which [pressure spring] tends to continuously press the extension into the direction towards the support element.

By that means, it is possible to change the volume of the primary chamber while the volume of the precombustion chamber still remains uniform, so that a changed overall combustion space volume results. The mixture ratio of combustible gas and air in the primary chamber can consequently be significantly influenced, and the energy produced in the primary chamber and given off by the operating tool consequently adjusted. Through the change of the size of the primary chamber, for example, the level of the precompression in the primary chamber, the level of the turbulence produced in the primary chamber, as well as the energy losses through the cooling off of the burning combustible gas mixture can be changed, so that the energy used by the operating tool can be adjusted in wide ranges and to desired working conditions or environmental conditions.

The support element is externally formed convex, for example, so that sufficient space for the accommodation of the central extension of the separating plate and the pressure spring is present. The size of the precombustion chamber is determined by the length of the central extension in connection with the outward curvature of the support element and, specifically so, independently of which axial position the support element assumes. The position of the combustion chamber wall, and thereby the size of the primary chamber can consequently be changed upon the axial displacement of the support element or of the catch unit, while the volume of the precombustion chamber remains constant.

The combustion chamber, which is divided into several partial combustion chambers, can also be collapsible. This means, in the present case, that the separating plate can be moved against a combustion chamber base wall, while the combustion chamber wall can be moved against the separating plate. In this manner, the precombustion chamber and the primary chamber can be moved together. For this purpose, the combustion chamber wall is driven into the axial direction of the combustion chamber, whereby it correspondingly entrains the separating plate in its movement. The stated pressure spring always ensures that the separating plate is pressed in the direction towards the combustion chamber wall. It is thereby possible that, upon the collapsing of the combustion chamber, the precombustion chamber collapses first, in order to be emptied of residual gases, and that, upon the loading of the partial combustion chambers, the precombustion chamber is loaded last, in order to likewise be ventilated after the ventilating of the primary chamber.

An additional adjusting screw could, of course, be additionally provided in the axial direction of the combustion chamber inside the central activation extension, which [adjusting screw] could stress the cylinder axis of the separating plate with its end pointing in the direction towards the combustion chamber in order to also to be able to provide for a change of the distance between the separating plate and the combustion chamber wall. The volume of the precombustion chamber could thereby also be adjusted.

One example of implementation of the invention will be illustrated in further detail with reference to the single figure.

The figure depicts an axial section through a combustion-operated placing device for attachment elements in the area of its combustion chamber, which is formed as a collapsible combustion chamber. The placing device has a cylindrically-formed combustion chamber (1), with a cylinder wall (2) and an annular base wall (3) connecting to that. An aperture (4), with which a guide

cylinder (5) is connected and which has a cylinder wall (6) and a base wall (7), is located in the center of the base wall (3). Inside the guide cylinder (5), a piston (8) is supported in a sliding and displaceable manner and, specifically so, in the longitudinal direction of the cylinder of the guide cylinder (5). The piston (8) consists of a piston plate (9) which points towards the combustion chamber (1), as well a piston rod (10) connected centrally with the piston plate (9), which [piston rod] partially projects out from the guide cylinder (5) through a penetrating aperture (11) in the base wall (7).

In the figure, the piston (8) is located in its retracted resting position. The side of the piston plate (9) which is oriented towards the combustion chamber (1) more or less seals off with the inner side of the base wall (3), and the piston plate (10) projects only a small amount outwardly over the base wall (7). In order to seal off the spaces on both sides of the piston plate (9) against one another, sealing rings (12) on the external circumference of the piston plate (9) can be provided. A catch unit (13) serves to position the piston (8) in its resting position.

A cylinder plate (14), which can be termed a movable combustion chamber wall, is located inside the combustion chamber (1). The combustion chamber wall (14) is displaceable into the longitudinal direction or axial direction of the combustion chamber (1) and has an annular sealing unit on its external circumferential edge in order to seal off the spaces in front of and behind the combustion chamber wall (14). Furthermore, the combustion chamber wall (14) has a central penetrating aperture (16) with an annular circumferential sealing. An additional separating plate (18) is located between the combustion chamber wall (14) and the base wall (3). The separating plate (18) is likewise formed in a circular manner and has an external diameter which corresponds to the internal diameter of the combustion chamber (1). On the side pointing towards the combustion chamber wall (14), the separating plate (18) is connected with a cylindrical extension (19), which projects through the central penetrating aperture (16) of the combustion chamber wall (14), and the length of which corresponds to a multiple of the thickness of the combustion chamber wall (14). The circumferential sealing along the edge of the penetrating aperture (16) is thereby tightly joined with the external circumferential surface of the cylindrical extension (19). On its free end, the cylindrical extension (19) has an annular extension (20) projecting over its circumference. The external diameter of the annular extension (20) is greater than the internal diameter of the penetrating aperture (16). A pressure spring (15) which tends to always press the separating plate (18) in the direction towards the combustion chamber wall (14) is located between the annular extension (20) and the side of the combustion chamber wall (14) oriented to it.

For the displacement of the combustion chamber wall (14) in the longitudinal direction or axial direction (X) of the combustion chamber (1), three drive rods (23), for example, only one of which is to be seen in the figure, are solidly connected with the combustion chamber wall (14), being distributed over its circumference at equal angular distances. The drive rods (23) lie in parallel to the cylinder axis of the combustion chamber (1), and externally laterally to the cylinder wall (6). The drive rods (23) thereby each pass through a penetrating aperture (24) in the separating plate (18), as well as an additional penetrating aperture (25) in the base wall (3). Another internal circumferential sealing for sealing off the spaces on both sides of the base wall (3) is located there. The drive rods (23) and the combustion chamber wall (14) are connected with one another, such as by means of screws (27), for example, which are guided through the combustion chamber wall (14) and are screwed into the drive rods (23) on the frontal side. The free ends of the drive rods (23) are connected with one another by means of a drive ring (28), which lies concentrically to the cylinder axis of the combustion chamber (1) and encompasses the guide cylinder (5). The drive ring (28) can thereby bolted with the drive rods (23) by means of screws (29) in such a manner that the screws (29) pass through the drive ring (28) and are screwed into the free frontal sides of the drive rods (23). On each of the drive rods (23), a pressure spring (30), which is supported on the outer side of the base wall (3) and presses the drive ring (28), lies between the drive ring (28) and the base wall (3). The pressure spring (30) thereby tends to always press the combustion chamber wall (14) in the direction towards the base wall (3).

A ventilating- / evacuating valve (31) is additionally located in the area of the annular base wall (3). This is only indicated schematically. As will be described further below, this valve (31) serves to supply fresh air into the combustion chamber (1), as well as for the expulsion of combusted residual gases from the combustion chamber (1). In the operating condition of the operating tool indicated in the figure, shortly before the ignition of the combustible gas mixture in the combustion chamber (1), the ventilating- / evacuating valve (31) is held closed and, specifically so, by means of the drive ring (28). If it is distanced from the base wall (3), then the ventilating- / evacuating valve (31) makes a transition into the opened condition.

It should be additionally mentioned that the separating plate (18) has several penetrating apertures (38) on its circumference side, which [penetrating apertures] each have the same distance from the cylinder axis of the combustion chamber (1). Furthermore, exhaust apertures (39) for the outflow of air from the guide cylinder (5) if the piston (8) is moved into the direction of the base wall (7) are located on the lower end of the guide cylinder (5). Furthermore, a damping device (40) for the damping of the movement of the piston (8) is

located on the lower end of the guide cylinder (5). If the piston (8) passes beyond the exhaust apertures (39), then exhaust gas can escape from the exhaust apertures (39).

A support element (43) formed as a circular plate is located above the combustion chamber wall (14). This support element (43) is inserted into a circumferential groove (44) on the free end of the combustion chamber (1) and is secured there with the help of a locking ring (45) which is, by means of its external threading, screwed into a correspondingly-formed internal threading (46) of the combustion chamber (1). Upon the movement of the combustion chamber wall (14) in the direction away from the base wall (3), the support element (43) consequently forms a catch unit for the combustion chamber wall (14). The support element (43) is additionally formed in a convex manner so that it has, in the center, a greater distance from the combustion chamber wall (14) than it does at its edge.

In the central area of the support element (43), this has a central extension (45), by means of which the support element (43) is rotatable. It is to be seen in the figure that, in the operating condition of the operating tool depicted there, the free end of the cylindrical extension (19) strikes against the surface of the support element (43) pointing downwardly. By means of the annular flange (20), the pressure spring (15) thereby presses the free end of the cylindrical extension (19) upwardly against the support element (43) so that, upon the rotation of the support element (43), the primary chamber (22) is enlarged or reduced, but the volume of the precombustion chamber (21) remains constant, however.

Another two radial penetrating apertures (41 and 42), which are spaced from one another in the axial direction, are located in the cylinder wall (2) of the combustion chamber (1). Outflow channels, not depicted, of dosing valves, also not depicted, through which fluid combustible gas, for example, can be injected into the partial combustion chambers (21 and 22) in a dosed manner project into these penetrating apertures (41 and 42) from the outside.

It should be additionally noted that the central extension (19) connected with the separating plate (18) is, in its area oriented to the separating plate (18), formed as an ignition enclosure (51) for the accommodation of an ignition device (52). This ignition device (52) serves for the production of an electrical spark for the purpose of igniting a combustible gas mixture in the precombustion chamber (21).

As will be described in further detail further below, the ignition device (52) is located in the interior or in a central area of the ignition enclosure

(51) which is provided, on its circumferential side, with penetrating apertures (53) through which a flame front can exit from the ignition enclosure (51) into the precombustion chamber (21).

The manner of action of the placing device will be described in further detail in the following.

If the placing device is located in the resting position, then the combustion chamber (1) is completely collapsed, whereby the separating plate (18) is supported on the base wall (3), and the combustion chamber (14) [is supported] on the separating plate (18). The piston is located in its retracted resting position, so that practically no more space is also present between it and the separating plate (18), if a slight gap between these is disregarded. The placing of the plates (18 and 24) on one another comes about through the fact that the pressure spring (30) presses the drive ring (28) away from the base wall (3), and the drive ring (28) entrains the combustion chamber wall (14) by means of the drive rods (23). In this condition, the drive ring (28) also lies at a distance from the ventilating- / evacuating valve (31), so that this is open.

If, in this condition, the placing device is pressed with its forward tip against an object, into which an attachment element is to be driven, then the pressing force acts on the drive ring (28) by means of a mechanism, which is not depicted (only indicated roughly as [50]), and displaces this [drive ring (28)] in the direction towards the base wall (3) and, specifically so, with the pressing of the placing device against the stated object. The combustion chamber wall (14) is thereby moved away from the base wall (3) and, at the same time, entrains the separating plate (18), since the latter is pressed, by means of the pressure spring (15), against the lower side of the combustion chamber wall (14). The system of the combustion chamber wall (14) and separating plate (18) is consequently lifted up in common, until the free end of the cylindrical extension (19) strikes against the lower end of the support element (43). By that means, the movement of the separating plate (18) away from the base wall (3) is blocked. The primary chamber (22) is now completely loaded. Upon the further displacement of the combustion chamber wall (14) in the stated direction, the pressure spring (15) is compressed, and the combustion chamber wall (14) is finally moved against the support element (43) acting as a catch unit and comes to stop. The precombustion chamber (21) is now also completely loaded. The size of the precombustion chamber (21) is determined by the length of the central extension (19) and remains practically constant. The size of the primary chamber (22) results from the axial section of the support element (43).

During the loading of the combustion chamber (1), air can already be suctioned into the primary chamber (22) and, specifically so, through the

ventilating- / evacuating valve (31), which is still open in this condition. It also remains open during the further loading of the precombustion chamber (21), so that this can also be ventilated through the penetrating apertures (38). Shortly before the precombustion chamber (21) is completely loaded, the fluid gas is supplied through the penetrating apertures (41 and 42).

If the lever or trigger of the placing device is now activated, then an ignition spark is produced by the electrical ignition device (52) inside the ignition enclosure (51). Even before that, or shortly after, the drive ring (28) is locked and can no longer be moved in the axial direction. The mixture of air and combustible gas preadjusted in each of the chambers (21 and 22) by means of dosing begins to burn, first of all, in the precombustion chamber (21), whereby the flame front diffuses radially at a relatively slow speed in the direction of the penetrating apertures (38). An uncombusted mixture of air / combustible gas is thereby displaced in front of it, which [mixture] passes through the penetrating apertures (38) into the primary chamber (22) and produces turbulence there, as well as a precompression. If the flame front reaches the penetrating apertures (38) to the primary chamber (22), then the flames, caused by the relatively small cross-sections of the penetrating apertures (38), cross over, as jets of flame, into the primary chamber (22) and produce additional turbulence here. The thoroughly-mixed turbulent mixture of air / combustible gas in the primary chamber (22) is ignited over the entire surface of the jets of flame. It now burns at a high speed, which leads to a great increase in the level of efficiency of the combustion.

By that means, the piston (8) is acted upon and moved at high speed into the direction of the base wall (7) whereby, at the same time, the air from the guide cylinder (5) is driven outwardly through the exhaust apertures (39). In a short time, the piston plate (9) passes beyond the exhaust apertures (39), so that the exhaust gas can escape through them. An attachment element is now placed by means of the piston rod (10) moving out. After the placing, or after the completed combustion of the mixture of air / combustible gas, the piston (8) is brought back, by means of thermal recovery, into its starting position, since an underpressure is produced behind the piston through the cooling off of the flue gas remaining in the combustion chamber (1) and in the guide cylinder (5). Until the piston has reached its starting position in accordance with Figure 2, the combustion chamber (1) must remain tightly closed.

After it has been guaranteed that the piston (8) has again reached its starting position depicted in the figure, the previously-noted locking of the combustion chamber wall (14) or drive ring (28) is ended. The pressure spring (30) now presses the drive ring (28) away from the base wall (3), so that the drive ring (28) relieves the ventilating- / evacuating valve (31), and this can open.

Upon the additional effect of the pressure spring (30), the drive ring (28) is removed further from the base wall (3) and entrains the combustion chamber wall (14), by means of the drive rods (23), into the direction towards the base wall (3). The pressure spring (15) first of all brings it about that the separating plate (18) is still not entrained, so that the precombustion chamber (21) first of all collapses and is thereby evacuated of exhaust gases by way of the penetrating apertures (38) and the ventilating- / evacuating valve. Finally, the combustion chamber wall (14) also entrains the separating plate (18) if it strikes against this. The primary chamber (22) now begins to collapse, and is freed of exhaust gases by means of the ventilating- / evacuating valve (31). Finally, the separating plate (18) comes to lie on the base wall (3), and the combustion chamber wall (14) [comes to lie] on the separating plate (18). The operating tool has now assumed its resting position.

Patent Claims

1. A movable, combustion-operated operating tool, particularly a placing device for attachment elements, which has a combustion chamber (1) for the ignition of a combustible gas mixture, **characterized in that,** the size of the combustion chamber (1) is adjustable.

2. An operating tool in accordance with claim 1, **characterized in that,** the size of the combustion chamber (1) is adjustable through displacement of a combustion chamber wall (14).

3. An operating tool in accordance with claim 2, **characterized in that,** the displaceable combustion chamber wall (14) is a combustion chamber frontal wall which is displaceable in the axial direction (X) of the combustion chamber (1).

4. An operating tool in accordance with claim 3, **characterized by,** a catch unit (43) for the displaceable combustion chamber wall (14), which [catch unit] is adjustable in the axial direction (X) of the combustion chamber (1).

5. An operating tool in accordance with claim 4, **characterized in that,** the catch unit (43) is formed as a support element (43) traversing the displaceable combustion chamber wall (14), which [support element] is held on the inner wall of the combustion chamber (1).

6. An operating tool in accordance with claim 5, **characterized in that,** the support element (43) can be screwed, by means of an external threading, into an internal threading of the combustion chamber (1).

7. An operating tool in accordance with claim 5 or 6, **characterized in that,** the support element (43) is formed in the form of a circular plate.

8. An operating tool in accordance with claim 5, 6, or 7, **characterized in that,** the support element (43) supports a preferably central activation extension (45).

9. An operating tool in accordance with one of the claims 5 to 8, **characterized in that,** inside the combustion chamber (1), on the side of the displaceable combustion chamber wall (14) turned away from the support element (43), a separating plate (18) is positioned with an extension (19) which projects through the combustion chamber wall (14) and can be acted upon by the support element (43).

10. An operating tool in accordance with claim 9, **characterized in that,** a pressure spring (15) is positioned between the free end of the extension (19) and the displaceable combustion chamber wall (14).

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1 page(s) of diagrams follow.

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